Selection Rules for Light Scattering by Localized Eigenmodes of the Menger Sponge Fractal

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An effort to localize electromagnetic (EM) waves in a three-dimensional fractal was reported recently [1,2]. It was claimed that a quality (Q) factor as large as 610 was observed by an experimental study of microwave transmission and reflection for the Menger sponge fractal made of an epoxy resin with dielectric constant of 2.8. However, there was an ambiguity in the interpretation of the experimental data and the Q factor of 610 was an apparent overestimation. However, as I will show in this presentation, localized EM modes with the Q factor of several hundreds can certainly be realized in the Menger sponge when the dielectric constant is increased to 8.8 (mixture of epoxy resin and metal oxides). I will show this by the numerical simulation of dipole radiation based on the FDTD (finite-difference time-domain) method. The eigenfrequencies, Q factors, and field distributions of the localized modes will be presented. In addition, the selection rules for the 90-degree light scattering due to the symmetry of the eigenmodes will be derived and compared with the calculated spectra.

[1] M. Wada-Takeda et al., *Phys. Rev. Lett.*, **92**, 093902 (2004).
[2] M. Wada-Takeda et al., *Technical Digest of PECS-V*, 85 (2004).